A Workshop to Develop Priorities and Approaches

MONTEREY BAY
NATIONAL MARINE SANCTUARY
ECOSYSTEM MONITORING

April 20-21, 2000
Monterey Conference Center

A Workshop to Develop Priorities and Approaches: Monterey Bay National Marine Sanctuary Ecosystem Monitoring

A joint project of the Monterey Bay National Marine Sanctuary, Monterey Bay Aquarium Research Institute, and Monterey Bay Aquarium

Sponsored by the David and Lucile Packard Foundation

Hosted by the Monterey Bay Sanctuary Foundation

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EXECUTIVE SUMMARY

This document provides the results of a workshop held on April 20-21, 2000 to identify, prioritize and draft basic monitoring approaches for the key questions to be addressed in the Monterey Bay National Marine Sanctuary (MBNMS) ecosystem monitoring plan. The document is composed of five main sections and the three appendices cited are available upon request:

Overall Rationale and Objectives - The aim of the MBNMS ecosystem monitoring plan is to detect natural and human induced changes to Sanctuary resources and advise managers on necessary steps to protect those resources. The Central California Coast is uniquely suited for such a task because of its extensive research and management communities, who are eager to better understand and preserve our local marine environment. The monitoring plan will be based on two fundamental concepts. It will (1) take a comprehensive ecosystem approach that integrates historic data sets and existing monitoring programs with newly initiated efforts to fill critical gaps in our knowledge, and (2) both utilize data directly and effectively disseminate information to researchers, educators, managers and the public.

Methods for Developing the Monitoring Plan- MBNMS is developing its ecosystem monitoring plan in a systematic manner that includes a background survey of historic data and ongoing programs, a workshop to develop priorities and approaches (results presented here), and work sessions with an advisory committee and selected experts to identify monitoring gaps and develop specific monitoring strategies.

Workshop Outline - The "Workshop to Develop Priorities and Approaches" was organized in a structured format and designed to build consensus among participants. Although considerable information was generated before the workshop, MBNMS asked the participants to help determine monitoring needs and methods. More than 80 regional academic scientists and resource managers, from over 30 different organizations, participated in the workshop held in Monterey, California. Participants were placed in breakout discussion groups according to their area of expertise and facilitators coordinated their activities.

Summary of Workshop Results - The consensus among participants, facilitators and workshop organizers was that this process was very successful in characterizing a series of priority questions for an MBNMS ecosystem monitoring plan. In addition to the topic specific results listed in this document, several basic priority issues were identified:

1) There is a need for better basic mapping, baseline surveys/characterizations and assessment of resources in almost all areas of the Sanctuary.

2) A long-term, historic perspective is needed to detect natural and human induced changes to Sanctuary resources.

3) In general, the most important anthropogenic impacts to monitor in the Sanctuary are related to pollution and fishing.

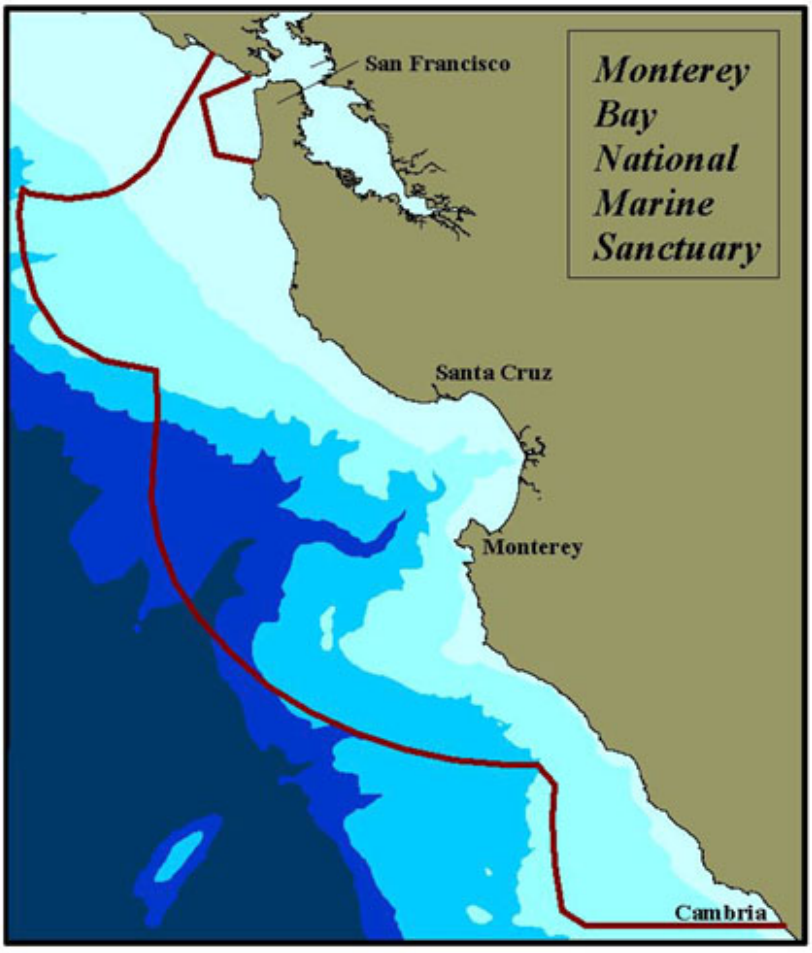
4) The MBNMS monitoring plan should have the ability to quickly respond to unforeseen important events (e.g., oil spills, harmful algal blooms, and massive marine mammal strandings).

Breakout Group Results - The specific results from each breakout group, including lists of attendees, issues of concern, priority questions and priority question characterizations are presented. The text in this section of the report was recorded by rapporteurs during the vari-

ous workshop activities, with only minor revisions and corrections.

Appendices - 1) a summary table of historic data sets and ongoing monitoring programs; 2) a list of the MBNMS Research Activities Panel members; and 3) a complete list of participants invited to the workshop. These items are available through the research program at MBNMS.

The specific workshop results listed on the following pages are now being used, in conjunction with the summary table of historic data sets and ongoing programs (Appendix 1), to identify which priority questions are currently being addressed and where critical gaps in our understanding of MBNMS resources remain. Results of this analysis will be the framework for the Sanctuary-wide monitoring plan, which will be completed by the end of Summer 2000.



PROJECT OVERVIEW

OVERALL RATIONALE AND OBJECTIVES

The management plans for all National Marine Sanctuaries mandate implementation of monitoring programs. The purpose of such programs is to detect natural and human induced changes to Sanctuary resources and advise resource managers on necessary steps to protect those resources. New, directed monitoring efforts can then be employed to determine the success of management strategies.

With over 20 marine research institutions, the greater Monterey Bay area is an internationally recognized leader in marine research, resource management, and policy. The entire Monterey Bay National Marine Sanctuary can be managed more effectively by summarizing and integrating information from existing monitoring efforts at these regional institutions and by identifying the critical gaps in our current knowledge. With this information, important issues will be identified and prioritized in a new long-term, integrated ecosystem monitoring plan that relies on existing data sets, supports and augments current research/monitoring efforts, and addresses the important gaps detected. This comprehensive plan will be the blueprint for new monitoring efforts locally at the Monterey Bay National Marine Sanctuary, as well as a model for other National Marine Sanctuaries and marine protected areas worldwide.

The Sanctuary, with the support of regional researchers and resource agencies, envisions serving as a "hub" for integrating ongoing and newly initiated monitoring projects. The field work will be done largely by scientists in the MBNMS region and supported by a combination of existing program funds, new project specific funding, NOAA funding, private foundation support, and state support. Information collected and synthesized will be continuously updated and disseminated to facilitate the sharing of meaningful data between researchers, managers, and the public.

The Monterey Bay National Marine Sanctuary is building its ecosystem monitoring plan in a systematic manner (Figure 1). The ultimate scope and breadth of the Sanctuary-wide plan, as well as outputs of specific monitoring programs, are in development. We expect to have those details resolved by the end of summer 2000. New monitoring efforts that fill critical gaps, extend historic data sets, or compliment ongoing programs will begin in 2001.

METHODS FOR DEVELOPING THE MONITORING PLAN

Compiling Existing Information
Beginning in July 1999, surveys of regional scientists and managers, and searches of reference material (peer-reviewed, "gray" and electronic) were conducted to identify programs and data sets that are pertinent to monitoring MBNMS resources. Biological, geology, physical, chemical, and human impact data were then assembled in a Summary Table (Appendix 1) of metadata for each of the following components of the Sanctuary:

- Dunes and Bluffs
- Bays, Estuaries and Riparian
- Rocky Intertidal and Nearshore (intertidal and subtidal, < 50 m)
- Sandy Beaches and Nearshore Soft Bottom (intertidal and subtidal, < 50 m)
- Deep Seafloor (> 50 m)
- Open Ocean (oceanography, zooplankton and smaller, from the surface to epibenthic)
- Pelagic Megafauna (larger than zooplankton, from the surface to epibenthic)

Identifying and Prioritizing Issues of Concern
The next step was to conduct a workshop with regional scientists and resource managers to identify and develop basic approaches for answering the key questions to be addressed in a new Sanctu-

ary-wide monitoring plan. The specific results of this workshop are described in this document.

Identify Gaps and Designing the New Monitoring Plan

Using the Workshop Results and the Summary Table of historic data sets and ongoing programs, MBNMS will work with local experts to identify critical gaps and develop specific monitoring strategies. The results of this exercise will be synthesized in the new, integrated ecosystem monitoring plan, which will be completed in August 2000.

Development Team

Development of the MBNMS ecosystem monitoring plan is led by Dr. Mario Tamburri, a Research Fellow with Monterey Bay Aquarium Research Institute. Dr. Tamburri is working closely with a MBNMS Ecosystem Monitoring Committee of:

William Douros, Superintendent, Monterey Bay National Marine Sanctuary

Dr. Andrew DeVogelaere, Research Coordinator, Monterey Bay National Marine Sanctuary

Dr. Chris Harrold, Director of Conservation Research, Monterey Bay Aquarium

Dr. Edward DeLong, Science Chair, Monterey Bay Aquarium Research Institute

Dr. Gregor Cailliet, Professor, Moss Landing Marine Laboratories

Dr. Jeffery Paduan, Associate Professor, Naval Postgraduate School

Dr. Peter Raimondi, Assistant Professor, University of California at Santa Cruz

Additional input and support is being provided by the MBNMS Research Activities Panel (RAP; Appendix 2), Monterey Bay Aquarium Research Institute, Monterey Bay Aquarium, and the National Marine Sanctuaries Program and Special Projects Office of NOS.

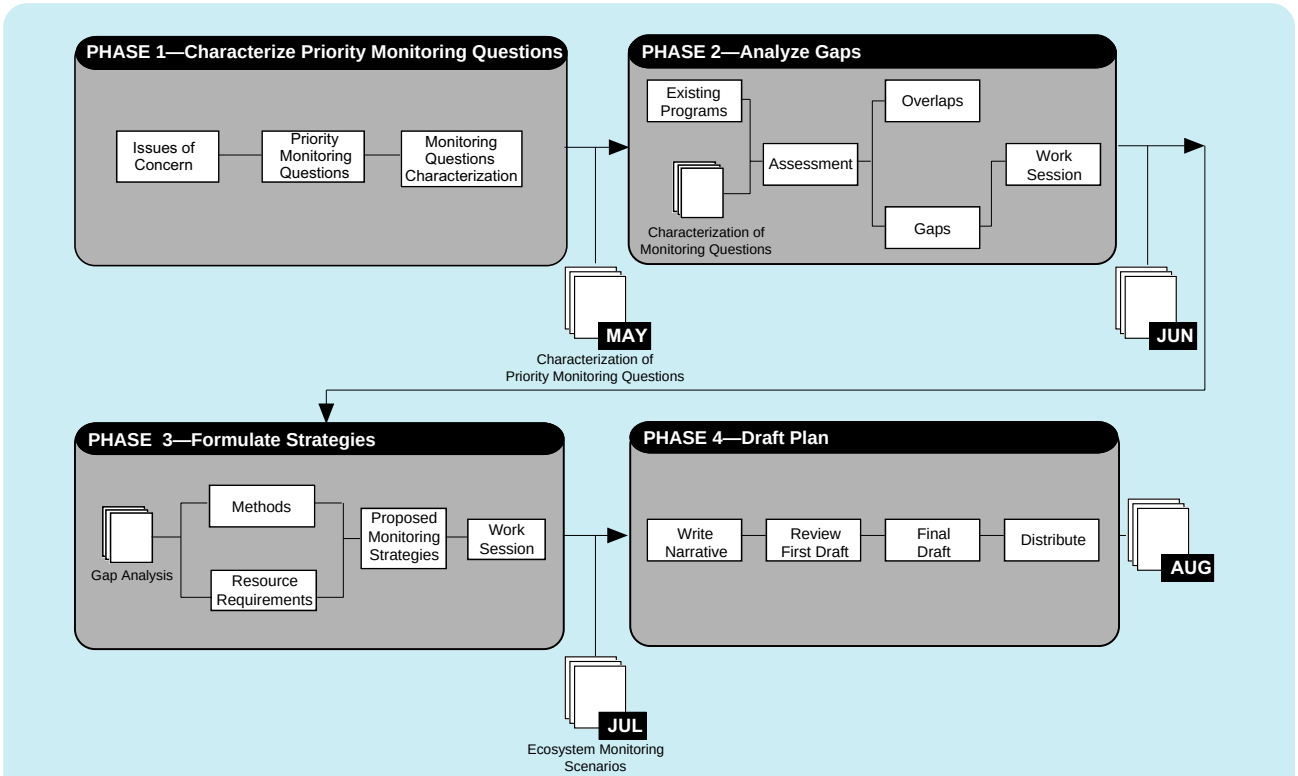


Figure 1. Developing an Ecosystem Monitoring Plan for the MBNMS

WORKSHOP OVERVIEW

WORKSHOP OUTLINE

Goals of the two-day workshop were to identify, prioritize, and draft basic monitoring approaches for the key questions to be addressed in the Monterey Bay National Marine Sanctuary ecosystem monitoring plan. It was held at the Monterey Conference Center on April 20th and 21st, 2000 and was sponsored by the David and Lucile Packard Foundation.

The workshop was organized in a structured format and designed to build consensus among participants (Figure 2). Although considerable information was generated before the workshop, MBNMS asked the participants to help determine monitoring needs and methods of investigation. Selected regional academic scientists and resource managers from 40 different organizations (Appendix 3) were invited to participate.

Over 80 scientists and managers from Central California were placed into one of seven discussion groups, organized by habitat types or topic of concern to the Sanctuary, according to their area of expertise:

- Dunes and Bluffs
- Bays, Estuaries and Riparian
- Rocky Intertidal and Nearshore
- Sandy Beaches and Nearshore Soft Bottom
- Deep Seafloor

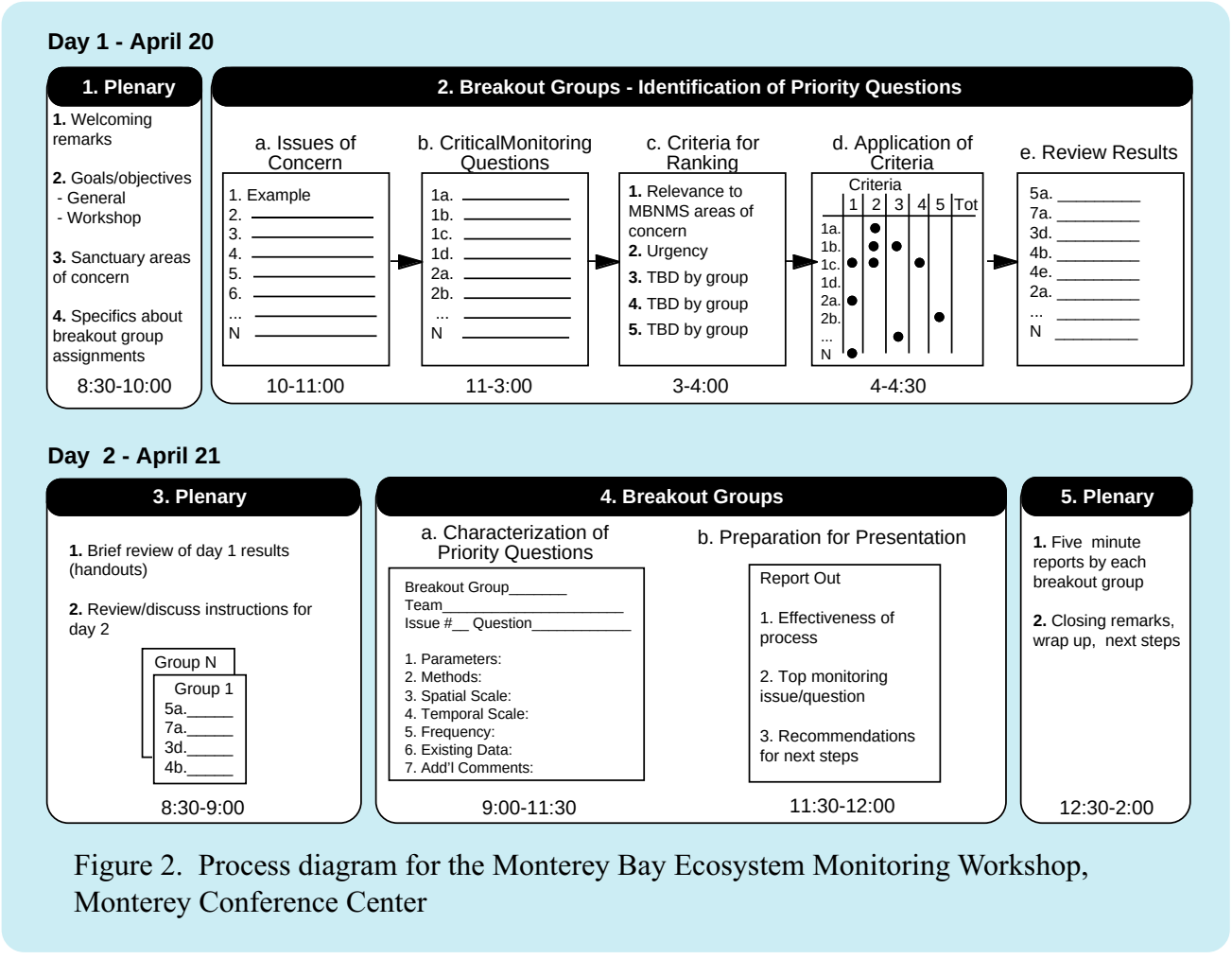


Figure 2. Process diagram for the Monterey Bay Ecosystem Monitoring Workshop, Monterey Conference Center

- Open Ocean
- Pelagic Megafauna

The goal of each breakout group on Day One was to list major issues of concern and their importance. From these issues, a series of monitoring questions were then developed. At the end of the day, participants ranked the monitoring questions to identify a group of top priority questions for their region or topic.

The focus of Day Two was to characterize the priority questions identified during Day One. The participants were asked to develop basic monitoring approaches for each question by listing:

a) parameters to measure
b) methods of monitoring those parameters
c) spatial scale needed for effective monitoring
d) temporal scale needed to identify changes
e) frequency needed to identify changes
f) existing data or programs that may address this or similar questions
g) any additional comments

SUMMARY OF WORKSHOP RESULTS

The consensus among participants, facilitators and workshop organizers was that this process was very successful in characterizing a series of priority questions for an MBNMS ecosystem monitoring plan. It was clear that each breakout group had a good mix of academic scientists, agency researchers, and resource managers with the necessary knowledge to address the tasks asked of them. The workshop not only brought together people with various strengths but also placed the work of individuals into a larger context.

Several useful suggestions were made during the workshop and will be considered when developing the overall MBNMS ecosystem monitoring plan. Those that were brought up by more than one participant or breakout group included:

- Locate, archive, and analyze historic data sets
- Standardize methods across programs
- There is a need for basic mapping, baseline surveys/characterizations and assessment of resources in almost all areas of the Sanctuary
- Effective data management, integration, and dissemination to managers and the public is critical
- All data should be geo-referenced to aid in its management and interpretation
- Watershed processes and inputs to the Sanctuary must also be considered
- The MBNMS Monitoring Plan should build off of successful existing monitoring programs
- The MBNMS Monitoring Plan should have the ability to quickly respond to unforeseen important events
- Public awareness and support of the MBNMS Plan is critical
- The MBNMS Monitoring Plan should be closely tied to education and management

Additionally, each of the seven breakout groups had rapporteurs recording discussions on issues of concern, priority questions, and characterization of priority questions. The following sections of this document present these discussions by breakout group. Although all the insightful comments and detail individual discussions that occurred during the workshop are not listed here, they will be considered when developing the overall MBNMS ecosystem monitoring plan.

DUNES AND BLUFFS

ATTENDEES

Facilitator:
- Charles Lester, *California Coastal Commission*

Rapporteurs:
- Karen Grimmer, *Monterey Bay National Marine Sanctuary*
- Maris Sidenstecker, *Monterey Bay National Marine Sanctuary*

Participants:
- John Dingler, *United States Geological Survey*
- Joey Dorrell-Canepa, *Consultant and Pebble Beach Co.*
- Joanne Kerbavaz, *California State Parks*
- Kriss Newman, *Point Reyes Bird Observatory*
- Peter Slattery, *Moss Landing Marine Labs*
- Ed Thornton, *Naval Postgraduate School*

PRIORITY ISSUES

- Rare and sensitive species
- Invasive species
- Cliff and dune erosion
- Identifying desired conditions
- Constraints on natural processes
- Prioritizing sensitive areas
- Impact of human access / exclusion zones
- Basic understanding of coastal structures and processes

CHARACTERIZATION OF PRIORITY QUESTIONS

What is the abundance and distribution of invasive dune and bluff species?

Parameters - Invasive and natural species, biodiversity and rate of change in community structure
Methods - Standard quantified transect/quadrat surveys, hyperspectral aerial surveys, aerial photos and mapping on GIS
Spatial Scale - All dunes and bluffs, or focus on most developed/visited versus most pristine
Temporal Scale - Decades
Frequency - Annual
Existing Data/Programs - Herbaria, Native Plant Society, State Parks, CalEPSI

What is the abundance and distributions of sensitive dune and bluff species?

Parameters - Sensitive and listed species, biodiversity and rate of change in community structure
Methods - Standard quantified transect/quadrat surveys, hyperspectral aerial surveys, aerial photos and mapping on GIS
Spatial Scale - All dunes and bluffs, or focus on most developed/visited versus most pristine
Temporal Scale - Decades
Frequency - Annual
Existing Data/Programs - Herbaria, Native Plant Society, State Parks

What are the rates and causes of dune and bluff erosion over time?

Parameters - Spatial location of cliff edges and dune morphology, characterization of rock and sediment type
Methods - LIDAR, aerial photo surveys and field surveys, comparisons of developed versus non-developed regions and mapping on GIS

Spatial Scale - All dunes and bluffs of the Sanctuary
Temporal Scale - Several decades, indefinitely
Frequency - Beach surveys several times a year and around large storm events, LIDAR every 2 years, aerial photos every year and comparison with historical records and photos

How has the distribution and structure of bluff and dune systems change on long-term time scales?

Parameters - Spatial location of cliff edges and dune morphology, species distribution and abundance
Methods - Core samples of dunes and bluffs for long-term (1000 year) perspective and compare current conditions with historic surveys and photos
Spatial Scale - All dunes and bluffs of the Sanctuary
Temporal Scale - Hundreds of years
Frequency - Once for all important locations

What are the impacts of human activities?

Using the above characterizations A) compare developed versus non-developed sites and quantify development impacts, B) compare highly visited versus visitor restricted sites and quantify numbers of visitors and their activities

Additional Comments - There is a need for dune reserves and better public education about these vulnerable habitats. Because they are easily accessible to everyone and human activities (particularly development) are destroying dunes but almost never creating dunes, preserving the remaining dunes is critical.

BAYS, ESTUARIES, AND RIPARIAN

ATTENDEES

Facilitator:
Rainer Hoenicke, *San Francisco Estuary Institute*

Rapporteur:
Susan Pufahl, *Monterey Bay National Marine Sanctuary*

Participants:
Ross Clark, *California Coastal Commission*
Ted Grosholz, *University of California at Davis*
Fred LaCaro, *State Water Resources Control Board*
Dave Paradies, *Bay Foundation of Morro Bay*
Holly Price, *Monterey Bay National Marine Sanctuary*
Don Potts, *University of California at Santa Cruz*
Victoria Seidman, *California State Parks*
Mark Stephenson, *Calif. Dept. of Fish and Game / Moss Landing Marine Labs*
Kerstin Wasson, Elkhorn Slough Foundation / National Estuarine *Research Reserve*
Fred Watson, *California State University Monterey Bay*
Karen Worcester, *California Regional Water Quality Control Board*
Susanne Worcester, *California State University Monterey Bay*

PRIORITY ISSUES

- Habitat Modification
- Pollution
- Biodiversity / Ecosystem Integrity
- Invasive Species
- Global, Large Scale Human Impacts

PRIORITY QUESTIONS (for each issue above)

What is the extent of impact?
Which resources are affected?
How can we best monitor effectiveness of restoration, prevention and preservation efforts?
What are the opportunities for restoration, prevention and preservation efforts?
What are historic conditions and carrying capacities?
Is status changing?
What is seasonal, annual, long-term and spatial variability?

CHARACTERIZATION OF PRIORITY ISSUES OR QUESTIONS

Habitat Modification - Habitat Loss

Parameters - Area of marsh, wetland and riparian habitats

Methods - Aerial surveys/GIS analysis for habitat acreage, field surveys to ground truth above and measure habitat structure (with biodiversity)

Spatial Scale - From satellite imagery to quarter

meter quadrats with emphasis on developed coastal areas

Temporal Scale - Every two to five years, indefinitely

Frequency - Winter and summer seasons

Existing Data/Programs - USGS hydrologic quad resources (NHD), numerous habitat maps

Habitat Modification - Bottlenecks, Sinks, Rivermouths, Confluences and Harbors

Parameters - Pollutant loading and biological impacts, sources, sediment and flow dynamics

Methods - Chemical, tissue, and sediment samples; plume characterizations with aerial photos; species composition at all levels

Spatial Scale - Specific regions or habitats of concern

Temporal Scale - Five years rotations and after storm events (depends on parameter), indefinitely

Frequency - Parameter dependent

Existing Data/Programs - NPDES, Mussel Watch, Municipalities

Is the number of invading species changing in the Sanctuary?

Parameters - Species richness of exotics, abundance of a few know pest species

Methods - Will vary by habitat and taxon

Spatial Scale - Entire MBNMS

Temporal Scale - Indefinitely

Frequency - Twice per year

Existing Data/Programs - Wasson *et al.* summary; Grosholtz detailed studies

Additional Comments - Must look beyond just estuaries and identify the source; a key is to detect invasions early for best chance of eradication

What are the impacts of invading species on specific communities and habitats?

Parameters - Species richness, abundance, distribution, and behavior of target species, selected physical or chemical parameters

Methods - Will vary by habitat and taxon

Spatial Scale - Entire MBNMS

Temporal Scale - Indefinitely

Frequency - Twice per year

Existing Data/Programs - Grosholtz impact of green crabs

Additional Comments - Must look at links between invasive and native species

What are estuarine ecosystem components?

Parameters - Communities structure, biodiversity, patchiness, and productivity in salt marshes, eelgrass, and mudflats

Methods - Use the diversity of bird species as indicators; sediment samples, species lists, invertebrates and microbial communities, density of dominant plants; remote sensing, GIS and local counts; comprehensive baseline surveys, inventory and mapping

Spatial Scale - Entire Sanctuary, down to individual habitats

Temporal Scale - Indefinitely

Frequency - Two to four times per year

Additional Comments - Long-term community involvement for funding and help in comprehensive sampling

Pollutants

Parameters - Nutrients, pathogens, sediments, organophospates, chlorinated hydrocarbons; bioaccumulation, toxicity analysis and basic physical parameters

Methods - Standard methods and new technologies (e.g., for nitrates)

Spatial Scale - Rivermouths and watersheds to help identify sources, at risk nearshore habitats

Temporal Scale - Indefinitely

Frequency - Monthly and after storm events

Existing Data/Programs - Numerous (e.g., MBNMS WQPP, CDFG, CRWQCB)

Additional Comments - Initial sampling is needed to identify watershed loading and source allocations contributing to loading

ROCKY INTERTIDAL AND NEARSHORE

ATTENDEES

Facilitator:
Paul Orlando, *NOAA*

Rapporteurs:
Dawn Murray, *University of California at Santa Cruz*
Christy Roe, *University of California at Santa Cruz*

Participants:
Bob Breen, *Fitzgerald Marine Reserve*
Mark Carr, *University of California at Santa Cruz*
Matt Edwards, *University of California at Santa Cruz*
Mike Foster, *Moss Landing Marine Labs*
Chris Harrold, *Monterey Bay Aquarium*
Dave Jessup, *California Department of Fish and Game*
John Pearse, *University of California at Santa Cruz*
Pete Raimondi, *University of California at Santa Cruz*
Paul Reilly, *California Department of Fish and Game*

PRIORITY ISSUES

- Inadequate baseline characterization of representative habitats
- Changes in abundance (adults and recruits), distribution and condition of target taxa and biodiversity
- Human-induced impacts on human and marine organism health and ecosystem structure and function due to: pathogens, pollutants, parasites, introduced species, habitat loss and alteration, exploitation, disturbance, trampling, rock rolling, drop anchors
- Natural impacts on human and marine organism health, ecosystem structure and function due to: a.) species interaction, b.) changes in physical/chemical /geological environment, c.) a and b interactions (not measured, an analysis activity)

CHARACTERIZATION OF PRIORITY QUESTIONS

Where are species located geographically within the rocky habitat?

Parameters - All species 0.5 cm or larger or very common/abundant species if smaller
Methods - Visual search in a delineated area, rank relative abundance
Spatial Scale - Intertidal to 50 m depth, representative sites throughout the entire length of the Sanctuary
Temporal Scale - Ongoing, indefinitely
Frequency - Decadal
Existing Data/Programs - Some intertidal, less shallow subtidal (0-30m), much less deep subtidal
Additional Comments - How will data be handled, quality control and archiving issues must be resolved, species lists and qualitative assessments of abundance are needed, include sample sites within and outside of reserves (full reserves include subtidal Big Creek, Hopkins, Pt. Lobos)

What are the temporal, spatial and geographic patterns of target taxa in rocky subtidal habitats?

How do spatial and temporal patterns of subtidal target taxa differ within and outside of marine protected areas?

What are the temporal, spatial and geographic patterns of target taxa in rocky intertidal habitats?

How do spatial and temporal patterns of intertidal target taxa differ within and outside of marine protected areas?

The four questions above can be characterized similarly by using patterns of target taxa in the subtidal and intertidal, as well as in and out of marine reserves.

Parameters - Abundance, size distribution (for select species), condition (for select species) and distribution within site, habitat association, recruitment, species list should come from initial survey in the first question

Methods - Standard methods appropriate to target taxa and depth (in situ with humans); Quantitative surveys, fixed and random surveys, stratified random; Aerial surveys for intertidal

Spatial Scale - Subset of sites surveyed in first question covering the length of Sanctuary, sites within and outside of reserves

Temporal Scale - Ongoing, indefinitely

Frequency - Annual, timing very important, but appropriate window for sampling is important, possibly time chosen to coincide with organism

Existing Data/Programs - More for invertebrates and algae but less for fish in the intertidal, less for invertebrates and algae but more for fish in the shallow subtidal (0-30m), little for fish, least for algae in deep subtidal (30-50)

Additional Comments - Collect and sample at spatial and temporal resolution correlated to changes in physical parameters

What are the select pathogen, pollutant and parasite (ppp) loads in sea otters and harbor seals (live and dead), shellfish and birds?

Parameters - Yearly mortality and causes of death, beach cast and population counts based on answers of questions below, selected ppp in living and dead organisms (otters, seals, birds, shellfish)

Methods - Standard analytical methods for live and dead

Spatial - Length of the Sanctuary for seals, otters focus on Pt. Conception to Half Moon Bay, birds within entire Sanctuary, for mussels need higher resolution than is currently provided by NOAA program

Temporal Scale - Ongoing, indefinitely

Frequency - Otters and harbor seals (dead) as opportunity arises (sampling permit required from FWS and MM department for live sampling), for every rehabilitated animal to the extent possible, opportunistic as research programs allow; shellfish should be tied in to the existing State Health Department and NOAA Mussel Watch programs; birds opportunistically

Existing Data/Programs - A lot of information on sea otters and harbor seals, much less on seabirds, a lot of specific contaminants information for shellfish, some on black abalone's parasite withering syndrome

What are the impacts of direct exploitation (e.g., fishing)?

Parameters - Species specific and location specific total catch and CPUE for target species and bycatch

Methods - Subtidal fish and invertebrates using direct onboard observation, shore-based creel surveys, total commercial and recreational landings; Intertidal using comparative information for species collected, bycatch, otters, birds, mammals; Kelp by monitoring harvesting

Spatial Scale - Throughout the Sanctuary at fishing ports and launch ramps (creel surveys), onboard boat surveys throughout Sanctuary

Temporal Scale - Ongoing, indefinitely
Frequency - Opportunistic depending on availability of fishing effort (for recreation and commercial)
Existing Data/Programs - A lot of data except for intertidal harvest of invertebrates and algae, none for scientific collection
Additional Comments - Reinvestigate the scientific collection system and analyze existing data

What are the impacts of non-consumptive disturbances (e.g., trampling) on intertidal and subtidal habitats?

Parameters - Human activity (e.g., kayakers, beach goers, divers, surfers, shell collectors, boating activity), species abundance, distributions and conditions and behavior of species, habitat changes
Methods - Methods for organisms and habitats as per questions above, census of human activities
Spatial Scale - Stratify sampling sites areas of high and low human activity, human vs. no human among sites, paired comparisons (e.g., Terrace Pt and Natural Bridges)
Temporal Scale - Ongoing
Frequency - Counts of humans as often as possible, number of people through park records (weekly to monthly) but more frequency where records exist, organisms annually
Existing Data/Programs - Very little human census, effects of trampling on intertidal organisms is spotty; subtidal data is low and boats/diving impact info is low

What are the impacts of changes in activity, abundance and distribution of apex predators (e.g., sea otters and harbor seals)?

Can be answered analytically based on results from above questions.

What are the spatial and temporal changes in temperature, storm activity, nutrients, upwelling, light transmission, current patterns, sea levels, river input (freshwater), and cloud cover/fog?

Parameters - Temperature, storm activity (wave height and period), nearshore nutrients, light transmission (variable), wind speed and direction, salinity, surge, visibility, currents, sea levels, river input, cloud cover/fog, erosion (cliff retreats)
Methods - There are really no standard methodologies for nearshore, prioritization to be determined
Spatial Scale - Link to monitoring sites
Temporal Scale - Ongoing
Frequency - Determined by instrument, to be determined and linked to biology
Existing Data/Programs - Temperature data exists (mostly surface), other parameters two ongoing programs USGS and PISCO

SANDY BEACHES AND NEARSHORE SOFT BOTTOM

ATTENDEES

Facilitator:

Steve Webster, *Monterey Bay Aquarium*

Rapporteur:

Kate Stanbury, *Moss Landing Marine Labs*

Participants:

Andrew DeVogelaere, *Monterey Bay National Marine Sanctuary*
Jon Geller, *Moss Landing Marine Labs*
George Gray, *California State Parks*
Dane Hardin, *Applied Marine Sciences*
Stacy Kim, *Moss Landing Marine Labs*
Jim Nybakken, *Moss Landing Marine Labs*
John Oliver, *Moss Landing Marine Labs*
Bruce Richmond, *United States Geological Survey*
Tim Stanton, *Naval Postgraduate School*
Curt Storlazzi, *University of California at Santa Cruz*

PRIORITY ISSUES

- Trawling Effects
- Watershed Impacts
- Climatic Change
- Beach Loss / Erosion
- Dredge Material Disposal
- Human Impacts on Beach Habitats
- Sewage Spills / Point Source Impacts
- Seafloor Cables
- Beach Cleanup

CHARACTERIZATION OF PRIORITY QUESTIONS

What are the physical and biological effects of trawl exclusion zones?

Parameters - Generate habitat maps with high resolution (0.5-1m), identify mega-fauna, identify infauna, identify grain size distribution, total organic carbon, larval supply/recruitment, larval transport

Methods - Maps using sidescan sonar, Roxanne, mulitbeam, video, LIDAR, SHOALS; Megafauna using trawl, diving, video, ground truth, ROV; Infauna using box core (quantitative device); Grain size using cores; TOC using cores; Recruitment using nets, larval traps; Transport using benthic tripod to assess bottom currents

Spatial Scale - Shore to shelf break, good replication inside and outside zone, transport distance

Temporal Scale - Decades

Frequency - Minimum baseline habitat map of one area and adequate samples inside and out, and benthos annually and seasonally (oceanographic); Preferred replicated reserves

Existing Data/Programs - Nearshore habitat map-

ping (Kvitek, Greene, CDFG), Schlining spot prawn (MLML thesis), some Carmel Bay and Canyon

What are the impacts of trawling in deep water habitats (>1000m)?

Parameters - Generate habitat maps with high resolution (0.5-1m), identify megafauna, identify infauna, identify grain size distribution, total organic carbon, larval supply/recruitment, larval transport
Methods - Maps using sidescan sonar, Roxanne, mulitbeam, video; Megafauna using trawl, video, ground truth, ROV; Infauna using box core (quantitative device); Grain size using cores; TOC using cores; Recruitment using nets, larval traps; Transport using benthic tripod to assess bottom currents
Spatial Scale - Deep water, size of exclusion zone dependant on fish life history, good replication
Temporal Scale - Decades
Frequency - Baseline habitat map of one area and adequate samples inside and out, and benthos annually and seasonally (oceanographic); Preferred replicated reserves
Existing Data/Programs - MCI data, Transect off San Francisco (1980s), Nybakken, Sablefish, Cailliet, MBARI ROV canyon video, GLORIA data (~100 m resolution)

What is the frequency and distribution of trawling activity?

Parameters - Where, when, historical, and current
Methods - CDFG records, NMFS interviews, observers
Spatial Scale - Throughout Sanctuary
Temporal Scale - Historic to present (all records available)
Frequency - Minimum once; Preferred annually
Existing Data/Programs - CDFG and NMFS reports
Additional Comments - Anticipate potential new nearshore fisheries and gather relevant information (e.g., sea cucumbers, urchins, surf perch, and impact of recreational fishing)

What are the sedimentary, biological, chemical inputs to the nearshore system from individual watersheds?

Parameters - TSS, bed load sediments, stream flow, microbiology (pathogens), water chemistry, persistent organic pollutants (POP), nutrients
Methods - Event driven sampling, standard water contaminant analysis
Spatial Scale - Every significant watershed
Temporal Scale - Minimum 5 years; Preferred decadal
Frequency - Minimum all major rain events, monthly during low flow periods
Existing Data/Programs - USGS water resources report
Additional Comments - Other sources then rivers exist (e.g., cliff erosion)

What are the ecological effects of the above inputs?

Parameters - Sediment chemistry, mineralogy sinks and budgets, microbiology, benthic community structure and function, bioaccumulation consequences to affected organisms, nutrient effects on community, physical disturbance of sinks
Methods - Standard techniques for sediment chemistry, mineralogy, and microbiology, culturing, staining, molecular (DNA probing), disturbance, sink and budgets, use Pb 210 for sedimentation rate; No standard techniques for sediment budget, nutrient effects on community, isotopic analysis of C and N, infaunal physiology, bioaccumulation, standard and new innovative techniques
Spatial Scale - Best case scenario is all watersheds; Minimum of Salinas, Pajaro and San Lorenzo Rivers
Temporal Scale - Minimum once
Frequency - Seasonally (3x/year)
Existing Data/Programs - USGS water resources report

Additional Comments - Impacts to pelagic system are important, minimum would be to characterize structure but function would be preferred

What are the effects of long-term primary productivity changes on near-bottom and benthic communities?

Parameters - Primary productivity data, flux of organic material to the seafloor, benthic community structure
Methods - Settling traps, benthic flux chambers, stable isotopes, community structure using grabs samples and box cores
Spatial Scale - Upwelling filaments, shelf slope break, oxygen minimum zone, near shelf shallow
Temporal Scale - Minimum 1x/year following upwelling but preferred 3x/year in perpetuity
Frequency - Seasonally (3x/year)

What are the patterns of extreme storms cycles, waves, currents, runoff, and sediment transport?

Parameters - Establish baseline including nearshore morphology as related to habitat structure
Methods - Long-term storm records, hindcasting, buoy records, instrumentation such as CODAR, ship mounted, remote sensing (SeaWIFS), modeling, LIDAR, beach profiling, ROV, AUV mapping, small watercrafts with DGPS and fathometer
Spatial Scale - Hotspots include: southern Monterey Bay, Santa Cruz, Big Sur, MBNMS
Temporal Scale - decades
Frequency - High resolution, long-term time series (~10-min intervals)
Existing Data/Programs - NOAA, Scripps, MBARI, NPS, USGS, Griggs & Scorlazzi (storm frequency)
Additional Comments - Minimum would be to maintain current systems/devices/buoys in place

What is the impact of long-term fluctuations on ecological systems?

Parameters - Benthic community structure, changes in sediments and other physical characteristics, changes in benthic communities function and species interaction
Methods - Standard methods described above
Spatial Scale - Across depth transects stratified by habitat type, near major watersheds and upwelling centers
Temporal Scale - Once per year
Frequency - Minimum, establish baseline and annually, preferred in perpetuity

DEEP SEAFLOOR

ATTENDEES

Facilitator:
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Rapporteur:
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PRIORITY ISSUES

- Role of temporal environmental variability (including disturbance)
- Anthropogenic effects (past and present)
- Mass material transport (sediment transport / submarine hydrology)
- Characterize benthic habitats and communities
- Canyon dynamics
- Sustainable fisheries
- Natural geohazards

CHARACTERIZATION OF PRIORITY QUESTIONS

What are the impacts of bottom trawling and other fishing gear on benthic habitats and communities?

Parameters - Impact of selective removal of organisms and impact of disturbance to substrate

Methods - Assess rates of community recovery by monitoring size, abundance, reproduction, of benthic megafauna, assess physical substrate recovery

Spatial Scale - Define appropriate scale for selected habitat types based on community structure, depth and chemistry; Intensively study shelf areas likely to be fished/impacted

Temporal Scale - Impacts are on a very short time scale but recovery may take decades

Frequency - Sampling frequency should coincide with expected rates of disturbance

Existing Data/Programs - Trawling log books, some published data

What are the impacts of bottom seafloor cables on benthic habitats and communities?

Parameters - Examine mega and macrofuana abundance and distribution before and after cable installation; Examine disturbance to benthic habitats (plowing/erosion), changes in chemi-

cal gradients of oxygen, sulfide

Methods - Seafloor mapping/surveys/sampling with ROV, trawls and grabs impacted and control sites

Spatial Scale - Replicate stations in impacted habitat types (e.g., sedimentary, rocky)

Temporal Scale - Single survey before installation and repeat surveys after disturbance until communities recover to background levels

Frequency - Annually, some parameters more often

Existing Data/Programs - MCI and other cable surveys

What are the impacts of chemical pollutants / contaminants on benthic habitats and communities?

Parameters - Distribution of contaminants in sediments, ground waters and in tissues of fauna (DDT, PCB, trace metals)

Methods - Standard sediment and tissue sampling techniques

Spatial Scale - In the vicinity of know contaminant sources, dependent on events

Frequency - Annually, some parameters more often

What are the seasonal, interannual, and longer time scales of environmental variability in the distribution and abundance of habitats and organisms?

Parameters - Fauna: mega and macro faunal abundance, size, reproductive condition and factors such as chemical tracers and pollutants in tissues. Habitat: physical and chemical variability in currents, turbidity, temperature, oxygen, chlorophyll or carbon input, and pollution or tracers.

Methods - Fauna using seafloor surveys/sampling with ROV, trawls and grabs; Habitat using electro-optic imaging or laser line scanning for high resolution imaging and mapping, moorings, landers, surveys with current meters, optical sensors (back scatter and chlorophyll), temperature and oxygen sensors; Kelp input using ROV/trawl surveys

Spatial Scale - Replicate stations stratified among defined habitat types such as continental shelf, slope, rise, canyon axis, canyon walls, abyssal plane

Temporal Scale - Monthly to annual, depending on parameter

Frequency - Sampling/study may be focused on particular interesting oceanographic or anthropogenic variability (e.g., ENSO, oil spill)

Existing Data/Programs - MBARI benthic surveys, limited benthic flux studies, NOAA trawl surveys

What is the role of natural / designated harvest refugia?

Parameters - Distribution, abundance, size/age class and reproductive condition of fish and macro invertebrates; Biodiversity (non-target species), larval transport combined with oceanographic parameters, adult spillover effects, substrate conditions

Methods - Identify existing natural harvest refugia, establish no-take areas for long-term monitoring, control site comparisons, ROV video/ still photos and bottom grabs

Spatial Scale - Depends on species of interest, life history requirements, network of small areas or few large areas and control sites

Temporal Scale and Frequency - Spawning cycles and other critical life history stages, determined by species

Existing Data/Programs - USGS habitat maps, trawl logbooks, data on no-take zones

Additional Comments - Marine Reserve Committee of PFMC and NCCES group

What is the paleo-oceanographic context of present day variability?

Parameters - Past environmental changes as recorded in layered sediments

Methods - Depth transects of sediment cores across margin

Spatial Scale - Various environments that differ in terms of sedimentation rate and depth, continental shelf, slope, rise, canyon axis, and abyssal plane
Temporal Scale - Current to 10,000 years is the highest priority with current to 100,000 and 1 million years lower priority
Frequency - Core samples may only need to be collected once
Existing Data/Programs - Some core samples already exist at MBARI and USGS
Additional Comments - Significant efforts in using specific techniques to establish sediment ages, environmental proxies and sediment dynamics are also needed

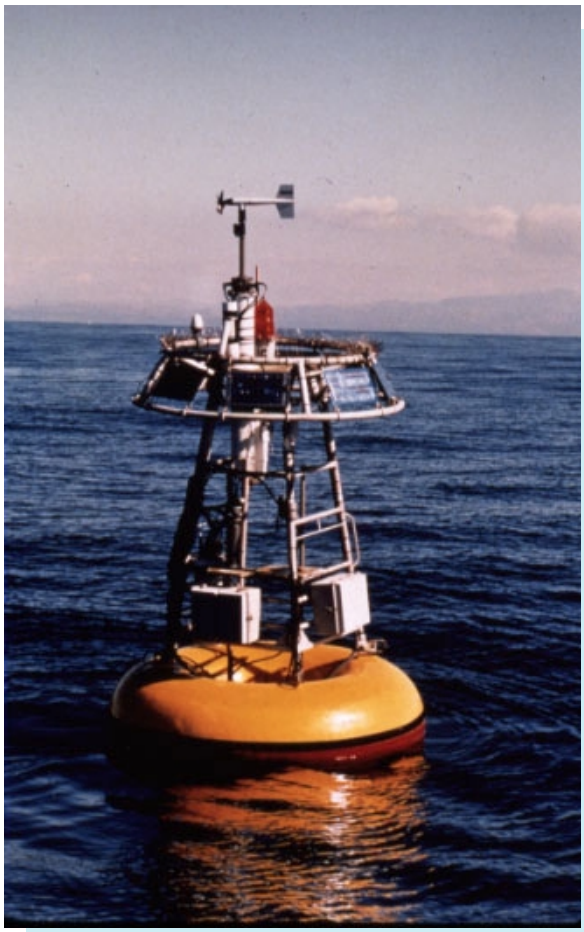
What are the sources and sinks of carbon and other material in the Sanctuary?

Parameters - Establish budgets, sedimentation (inorganic and organic) rates, erosion rates, distribution of processes, coupled with source inputs
Methods - Moorings to establish physics and dynamics, cores for geochronological analysis and benthic moorings
Spatial Scale - Static view, seasonal when appropriate, event response
Temporal Scale - Combine with paleo-oceanographic studies
Existing Data/Programs - Some data at MBARI and USGS

How do canyon dynamic processes and material transport affect the carbon and material budget?

Parameters - Flow velocities, temperature, salinity, oxygen, turbidity and biological and geological characterization
Methods - Time series of current meter, CTD, video, bottom coring, acoustic bottom characterization
Spatial Scale - Canyon head to fan, selected sites of time series along axis, 1 m resolution for bottom sampling
Temporal Scale - One to 10 years at one-hour resolution for field sensors
Existing Data/Programs - some at MBARI, USGS and NPS

OPEN OCEAN



ATTENDEES

Facilitator:

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PRIORITY ISSUES

- Climate forcing of ecosystem
- Anthropogenic perturbations to ecosystem
- Natural system (atmosphere/ocean) import export
- Inter-relationships between trophic levels in photic zone

CHARACTERIZATION OF PRIORITY QUESTIONS

Long line surveys: How do (climate-related) variations in the strength of the undercurrent and the depth of the thermocline influence ecosystem production and community structure?

Parameters - Physics by examining winds, ocean temperature, salinity, ADCP, nutrients, CFCs; Primary productivity by examining pigments (extracted chl or CTD/underway fluorometer or both), direct measures of primary productivity, POC (chlorophyll and transmissometer), community composition (functional groups); Zooplankton by using hydroacoustics, biomass, depth distribution, size structure, functional groups, mammals, birds

Methods - Moorings, ship surveys (CalCOFI style survey lines), acoustics, AUVs and gliders (which may replace some ship based measurements), satellites, drifters, floats

Spatial Scale - Ship surveys with 20km resolution, 250km offshore. Line 67 should perhaps stay, paired with line 63 (Half Moon Bay) but it is necessary to define the productive area by sampling beyond, varies from 100 to 200km 'wide'; Moorings such as M1 or M2 and M3, potentially finer scale if AUVs, gliders are employed

Temporal Scale - 10 years with review at that time with likely need for extension, important to envisage continuity on climate scales

Frequency - Moorings with sub-daily measurements, ship surveys surveying CalCOFI lines 6 times per year

Existing Data/Programs - There have been some survey of this type in the past, but nothing extant

Mesoscale surveys: How do the variations in the strength of winds and upwelling influence ecosystem production and community structure?

Parameters - Physics including winds, ocean temperature profiles, salinity, surface currents; Primary productivity including Chl (either extracted or underway/profiling fluorometer or all), profiling of underway transmissometer; Zooplankton using total biomass, vertical profiles, size structure, functional taxonomic groups, mammals, birds

Methods - Moorings & CODAR can provide physical and biological precursors to the mesoscale measurements. Resolve spatial and temporal variability and detect event-scale perturbations; Ship surveys with smaller vessels (e.g., Martin), 50 x 50km grid to focus on the bay; Hydroacoustics, zooplankton net tows, OPC, CTDs and underway fluorometer and transmissomoeter; Acoustics for vertical temperature structure/thermocline depth; Standard visual survey methods for mammals and birds

Spatial Scale - 50 x 50km survey area in Monterey Bay, 5km or less resolution

Temporal Scale - 3-5 years, then reassess

Frequency - Sub-seasonal stratified by oceanographic season (6-7 per year, not uniform)

Existing Data/Programs - Some in the past (some baseline data), but nothing extant

Additional Comments - Supports several monitoring and process studies, including HABs, habitat assessment for megafouna, human impact assessment, chemical tracer studies

What are the residence times and dispersal patterns of non-point source pollutants?

Parameters - Chemical species associated with human activities such as NO_3 from agriculture, saline groundwater intrusion effects, urban runoff, pesticides from agriculture, automobile and power plant activities

Methods - Find the correlation with natural tracers of land-sea contact, and observe dissipation away from coastal source, natural Ra223, 224 signal acquired by sea water on beach contact provides a natural tracer of boundary fluxes; Ocean physics for tracer motions

Spatial Scale - Over entire coastline, with emphasis on populated areas, from the coastal boundary to 10 miles out

Temporal Scale - The residence time of waters within Monterey Bay is about 10 days; The mixing pattern of a coastal source tracer is defined by upper ocean physics, and related to tide and wind forcing on a local scale

Frequency - Initial survey to locate hot spots; Seasonal (4-6 per year) afterwards, but try to catch the important signal of extreme events

Existing Data/Programs - One existing data set on the Ra 223, 224 natural signal (MBARI / Univ. of South Carolina), data on other anthropogenic components

Additional Comments - Requirement to connect with well data on land; Information is of great practical importance; The Ra connection is very novel, important new science that can provide a powerful tool

What are the impacts, both positive and negative, of flux of material from the coastal margins?

Parameters - Need to measure separately the solid material being transported in river systems vs. the dissolved load, coherence with on land well samples would also be very useful
Methods - Solid load using satellite pictures of river plumes, coring transects from shore outward; Water samples from rivers and wells
Spatial Scale - Tens of kilometers outward from a finite number of point sources (Salinas and Pajaro rivers)
Temporal Scale - Decadal, span at least two El Niño events
Frequency - Need frequent sampling in rainy season (at least monthly), less frequent in dry season; A response capability in response to extreme events is highly desirable
Existing Data/Programs - Many disjoint efforts, not truly focussed on this question; Dunes and Bluffs (sand load), Bays and Estuaries (water quality), Rocky Intertidal (sewage outfall), Sandy Beaches (sediment transport), Deep Seafloor (sedimentation/cores)
Additional Comments - Important for determining impact of dredge tailings being dumped into Sanctuary; This plan should be correlated with that for similar questions being asked in Sandy Beaches group; This topic should be of interest to the Deep Seafloor, and is being considered by them in addition to this effort

Where are areas of high vs. low risk to health of Sanctuary from military exercises and operations?

Parameters - Identify fragile ecosystem elements that could be adversely affected
Methods - Risk assessment of potentially deleterious effects of land, sea and air exercises within Sanctuary
Spatial Scale - Of the order of 2km
Temporal Scale - Of the order of 7 days
Frequency - On a case by case basis
Existing Data/Programs - None
Additional Comments - Provide feedback to DOD to minimize impact on Sanctuary

What are the impacts of acoustic monitoring on the health of the system being studied?

Parameters - Measure ambient acoustic noise levels (0-1000Hz)
Methods - Cabled hydrophone arrays
Spatial Scale - Approaches to SF, rest of Sanctuary
Temporal Scale - Sample continuously at 2000Hz
Frequency - Continuous
Existing Data/Programs - Existing arrays include CoACT at Pt Sur and ATOC at Pioneer, Historical shipping noise data sets
Additional Comments - MBNMS needs to preserve the Pioneer array for Sanctuary research and education; Make data available on the web to all; Resolve issues of concern surrounding assumed detrimental effects of acoustic energy on Sanctuary inhabitants

PELAGIC MEGAFAUNA

ATTENDEES

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Gary Sharp, *Center for Climate/Ocean Resources Study*

PRIORITY ISSUES

- Catch and bycatch of pelagic fisheries
- Influence of oceanographic (physical as well as biological) processes on past, present and future abundance and distribution of on all pelagic megafauna (including seabirds, tunas, swordfish, cetaceans, pinnipeds)
- Range expansion of pinnipeds
- Interaction of seabirds and marine mammals with human activities
- Effects of ecotourism (e.g., noise, oil, light)
- Ocean based anthropogenic effects
- Land based anthropogenic effects
- Environmental variability in climate and ocean processes
- Monitoring condition/health of pelagic megafauna (parasites, pollutant loads)
- Unforeseen events, and our ability to react quickly to them (e.g., unusual mortality events)
- Changes in the benthic habitat
- Distribution and abundance of pelagic megafauna species
- Identify and monitor critical habitats and processes
- Life histories of pelagic megafauna and their prey
- Public education and perspective on Pelagic Megafauna

CHARACTERIZATION OF PRIORITY QUESTIONS

What are the past, present and future distribution and abundance patterns of pelagic megafauna in the MBNMS for sensitive species, caught species (i.e. species affected by human actions) and indicator species, and what are the major natural influences on the patterns with respect to biological interactions (e.g., predators, prey, and competition)?

Parameters - Occurrence and distribution and relative abundance of observable and/or catchable pelagic megafauna (e.g., murres, blue whales, tuna, leatherback turtles, pelagic sharks), combined with lat/long

Methods - Fisheries and fisheries independent using ship/aerial surveys, general net sampling, acoustics, beach surveys, advance technology (e.g., LIDAR), hook and line surveys, biological samples, use CalCOFI and other transects, compile archeo-faunal data; Fishery dependent using on-board observers, landings, aerial surveys of vessels, logbooks, GPS, biological samples

Spatial Scale - Point Reyes to Cambria, and 80 miles offshore, adaptable to objectives
Temporal Scale - Indefinitely
Frequency - Fishery independent, 3 to 6 per year (at least one per oceanographic season)
Existing Data/Programs - CDFG (e.g., dockside sampling), NMFS (e.g., rockfish surveys, marine mammal surveys, monitoring gillnet fisheries), Point Reyes Bird Observatory, Beach Surveys (Sanctuary Programs, MB/GFNMS), Moss Landing Bird, marine mammal, fishes and macro-invertebrate surveys
Additional Comments - Need oceanographic and climatic data taken concurrently with fauna surveys and from other programs (e.g., MBARI, NOAA, NASA, UCSC). Need specimens for life history work (feeding, growth and reproduction condition factors).

What are the past, present and future distribution and abundance patterns of pelagic megafauna in the MBNMS for sensitive species, caught species (i.e. species affected by human actions) and indicator species, and what are the major natural influences on the patterns with respect to physical and chemical processes, and climate and environmental variability?

Parameters - Thermal properties, clouds, wind speeds, currents, upwelling indices, chemical properties
Methods - XBTs, CTD profiles, SSTs using shipboard intake, bucket samples and satellites, ADCP, Drifters, AUV, CODAR, RADAR, ship transects with CTD/Rosette samples, standard measure of nutrients and trace elements, paleosediment studies of historic conditions
Spatial Scale - Point Reyes to Cambria, and 80 miles offshore, adaptable to objectives
Temporal Scale - Indefinitely
Frequency - 3 to 6 per year (at least one per oceanographic season)
Existing Data/Programs - Several that should be integrated (e.g. CalCOFI, MBARI, NMFS, NASA satellites).
Additional Comments - Important to coordinate with historical data where possible for longer time series.

What are the major influences of fisheries on distribution and abundance patterns of pelagic megafauna in the MBNMS?

Parameters - Catch data using location data, general techniques used, effort data (CPUE, depth, soak time, mesh length; Biological data using size composition, sex and age composition
Methods - Onboard observers, standard stock sampling, logbook, catch and landings (ID: discards and incidental catches of turtles, birds and mammals), time series analysis
Spatial Scale - Point Reyes to Cambria, as far offshore as necessary
Temporal Scale - Ongoing, indefinitely
Frequency - Concurrence with any fishery, dependent surveys and whenever pelagic fishery is in operation (statistically representative)
Existing Data/Programs - Shore surveys (Beachcombers), CDFG landings (Pink slips) and trawl logbook, some NMFS logbooks (e.g., albacore, swordfish), observers, dockside sampling of some landings
Additional Comments - The various types of fisheries (including individual recreational, party boats and commercial fishing) need to be better differentiated, as any and either can create unique problems.

What are the critical habitats for pelagic megafauna in the MBNMS and how do they change over time?

Parameters - Observable/catchable indicator species of pelagic megafauna with temperature, bathymetry, prey abundance, primary productivity, vessel traffic (human presence)
Methods - Shipboard and aerial surveys, monitoring fishing activity, remote-sensing, bioacoustics
Spatial Scale - Entire MBNMS
Temporal Scale - Oceanographic seasons, indefi-

nitely

Frequency - One to two broad based per season, two to four focused surveys in critical habitats as defined by broad based surveys

Existing Data/Programs - CDFG, NMFS, MLML, UCSC, PRBO surveys

Additional Comments - Critical habitats are likely dynamic so there is a need to repeat sampling through time and space

What are the major land-based and ocean-based anthropogenic influences on the distribution and abundance patterns of pelagic megafauna in the MBNMS?

Parameters - Ocean based examining pollutants (e.g., noise, oil, solid waste), vessel traffic, water temperature (global warming); Land based examining pollutants (e.g., DDT, oil, PCBs)

Methods - Water samples for standard characteristic and contaminants, hydrophone array, beach surveys for solid waste, biopsy sampling, necropsies of dead animals, net sampling, vessel locations and fishing

Spatial Scale - Entire MBNMS

Temporal Scale - Indefinitely

Frequency - Monthly

Existing Data/Programs - CDFG, UCSC, Monterey and Santa Cruz County, beach surveys, NMFS, Stranding Network, USDA

Additional Comments - Recreational conflicts and anthropogenic effects